Washington Office of Superintendent of
PUBLIC INSTRUCTION

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CTE

Statewide Framework Document for: 470604

Automotive Technology 1

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments and leadership alignment may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for one credit of science.** The Washington State Science Standards performance expectations for high school blend core ideas (Disciplinary Core Ideas, or DCIs) with scientific and engineering practices (SEPs) and crosscutting concepts (CCCs) to support students in developing usable knowledge that can be applied across the science disciplines. These courses are to be taught in a three-dimensional manner. The details about each performance expectation can be found at Next Generation Science Standards.

School District Name	
Course Title: Automotive Technology 1	**Total Framework Hours:** 540
CIP Code: 470604 ☐ Exploratory ☒ Preparatory	**Date Last Modified:** December 30, 2020
Career Cluster: Transportation, Distribution and Logistics	**Cluster Pathway:** Transportation Operations

Course Summary:
A STEM Enriched Course Scope and Sequence that prepares individuals to engage in the specialized servicing and maintenance of all types of automobiles. This course includes instruction in the diagnosis of malfunctions in, the adjustment or repair of, and/or properly replacing of parts in, 4 of the 8 Nationally recognized NATEF/ASE units: Engine Repair, Manual Transmission & Axles, Brakes, and Electrical/Electronic Systems. "Soft/Life skills" (Leadership, Interpersonal, NATEF supplemental tasks, and 21st Century Skills) are embedded throughout this course along with a substantial correlation to Science, Physics and Chemistry as cross-referenced to the Next Generation Science Standards and NATEF publication, "Being Relevant Matters" cross referencing English, science, and math. Foundational courses to support student success in this course include Physical Science, Chemistry, Life Science, Earth Science, Engineering Technology, etc.
These are the NATEF/ASE units taught in this framework:
A-1 Engine Repair (90hrs. minor).
A-3 Manual Drivetrain and Axles (90hrs. minor).
A-5 Brakes (180hrs. major).
A-6 Electrical/Electronics (180hrs. major).
***Appendix A**, Electrical/Electronics, at end of this Framework, though not formatted according to state frameworks, shows every "Industry Standard Competency" individually aligned to science standards. All four sections and competencies are aligned and are available for determination.

Eligible for Equivalent Credit in: Science	**Total Number of Units:** 4

Unit 1: Engine Repair (ASE/NATEF: A1)	**Total Learning Hours for Unit:** 90

Unit Summary:

A: General: Engine Diagnosis; Removal and Repair (R&R)
B: Cylinder Head and Valve Train Diagnosis and Repair
C: Engine Block Assembly Diagnosis and Repair
D: Lubrication and Cooling Systems Diagnosis and Repair

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

- Students will have the ability to plan and conduct an investigation using quantitative methods to model, design, evaluate and refine a solution to complex problems using the following vehicle diagnostic and repair process for engine repair.

Vehicle Repair Procedures ● Concern – Cause – Correction	**21st Century / Leadership correlations**	**NGSS Science Correlations**
Verify / Confirm - Condition / Problem	Reason Effectively, Think Creatively,	Plan and conduct an investigation to gather evidence to compare the structure... Evaluate the validity and reliability of multiple claims... verifying the data when possible. Scientific inquiry... include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Analyze Data: Diagnose problem Data Notation: DTC's, Freeze Frame, Fuel Trim's, MAf's, measurements, mechanical and electronic testing.	Make Judgments and Decisions, Access and evaluate information, Apply technology effectively, Be self-directed learners, Be flexible,	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence... Use quantitative methods to compare the potential of different solutions. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Apply concepts of statistics and probability... to scientific and engineering questions and problems, using digital tools when feasible. Analyze data using computational models in order to make valid and reliable scientific claims.
P&A Parts / look up Labor/ Print Estimate	Create media products, Communicate with adults...	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Notation of performed / Estimate work order	Interact effectively with others,	Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

		Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Construct an oral and written argument or counter-arguments based on data and evidence.
Call Customer / sell job / Estimate Time	Use and manage information, Communicate with adults...	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
Fix: Follow Technical Instructions / Perform Service	Solve Problems, Implement innovations, Apply technology effectively, Produce results,	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. Use a model to provide mechanistic accounts of phenomena.

Leadership Alignment:

- Students incorporate their performance on assessments through YouScience.

21st Century Skills:

- Work Creatively with Others
- Make Judgments and Decisions
- Work Effectively in Diverse Teams.

Industry Standards and/or Competencies:

The following technical competencies are produced and endorsed by the **National Automobile Technical Education Foundation (NATEF) for Engine Repair. Automotive Service Excellence (ASE) area A1.**

A. General: Engine Diagnosis; Removal and Reinstallation (R & R)

1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.
2. Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins.
3. Verify operation of the instrument panel engine warning indicators.
4. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine necessary action
5. Install engine covers using gaskets, seals, and sealers as required.
6. Remove and replace timing belt; verify correct camshaft timing.
7. Perform common fastener and thread repair, to include: remove broken bolt, restore internal and external threads, and repair internal threads with thread insert.
8. Inspect, remove and replace engine mounts.
9. Identify hybrid vehicle internal combustion engine service precautions.
10. Remove and reinstall engine in an OBDII or newer vehicle; reconnect all attaching components and restore the vehicle to running condition.

B. Cylinder Head and Valve Train Diagnosis and Repair

1. Remove cylinder head; inspect gasket condition; install cylinder head and gasket; tighten according to manufacturer's specifications and procedures.
2. Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition.
3. Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action.
4. Adjust valves (mechanical or hydraulic lifters).

5. Inspect and replace camshaft and drive belt/chain; includes checking drive gear wear and backlash, end play, sprocket and chain wear, overhead cam drive sprocket(s), drive belt(s), belt tension, tensioners, camshaft reluctor ring/tone-wheel, and valve timing components; verify correct camshaft timing.
6. Establish camshaft position sensor indexing.
7. Inspect valve springs for square-ness and free height comparison; determine necessary action.
8. Replace valve stem seals on an assembled engine; inspect valve spring retainers, locks/keepers, and valve lock/keeper grooves; determine necessary action.
9. Inspect valve guides for wear; check valve stem-to-guide clearance; determine necessary action.
10. Inspect valves and valve seats; determine necessary action.
11. Check valve spring assembled height and valve stem height; determine necessary action.

C. Engine Block Assembly Diagnosis and Repair

1. Remove, inspect, or replace crankshaft vibration damper (harmonic balancer).
2. Disassemble engine block; clean and prepare components for inspection and reassembly.
3. Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine necessary action.
4. Inspect and measure cylinder walls/sleeves for damage, wear, and ridges; determine necessary action.
5. Deglaze and clean cylinder walls.
6. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine necessary action.
7. Inspect crankshaft for straightness, journal damage, keyway damage, thrust flange and sealing surface condition, and visual surface cracks; check oil passage condition; measure end play and journal wear; check crankshaft position sensor reluctor ring (where applicable); determine necessary action.

D. Lubrication and Cooling Systems Diagnosis and Repair

1. Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, heater core and galley plugs; determine necessary action
2. Identify causes of engine overheating.
3. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment.
4. Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required.
5. Inspect, remove, and replace water pump.
6. Remove and replace radiator.
7. Remove, inspect, and replace thermostat and gasket /seal.
8. Inspect and test fan(s) (electrical or mechanical), fan clutch, fan shroud, and air dams.
9. Perform oil pressure tests; determine necessary action.
10. Perform engine oil and filter change.
11. Inspect auxiliary coolers; determine necessary action.
12. Inspect, test, and replace oil temperature and pressure switches and sensors.
13. 13. Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; perform necessary action.

Aligned Washington State Academic Standards to be addressed in this 90 hour sequence of instruction.

Science	Below are the aligned standards addressed in this section: Integrated Science Lesson Objectives are from the 2014 NATEF/ASE publication "Being Relevant Matters" https://www.asealliance.org/wp-content/uploads/2016/05/Being-Relevant-Matters.pdf. NGSS and ELA Standards are correlated from a collaboration of Automotive, Science, ELA, OSPI teachers, and advisory group representative members. ***Integrated Science Lesson Objectives***

	Engine Repair: Engine operation 4- stroke engine theory, Compression & expansion of gas, Propagation, flame spread, Cylinder head type & construction & effects on airflow, Types of switches, Sending units & switches, Environmental issues handling waste products, Chemistry of sealants, Metallurgy, Torque to yield, Proper lifting techniques (Kinetics), Clamping force, on time use of fasteners, Chemical identification of cracks, Warpage issues, friction & wear, Chemical solvents & environmental issues, Antifreeze chemistry, Heat transfer (Thermodynamics), Pressure vs. boiling point (Boyle's Law/Charles's Law), Recycling coolant, Thermostat operation properties, Fluid coupling (Hydrodynamics), Oil weight, viscosity, additives, synthetics (Chemistry) **Washington Science Standards (Next Generation Science Standards):** HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS2-1 Motion and Stability: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Motion and Stability: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* HS-PS2-5 Motion and Stability: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS2-6 Motion and Stability: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* HS-PS3-1 Energy: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects) HS-PS3-3 Energy: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

	HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-PS4-2 Waves and their Applications in Technologies: Evaluate questions about the advantages of using digital transmission and storage of information HS-PS4-5 Waves and their Applications in Technologies: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* HS-LS2-7 Ecosystems; Interactions, Energy, and Dynamics: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* HS-ESS3-1 Earth and Human Activity: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2 Earth and Human Activity: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* HS-ESS3-4 Earth and Human Activity: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* HS-ETS1-3 Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 Engineering Design: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Unit 2: Manual Drive Train and Axles (ASE/NATEF: A-3)	**Total Learning Hours for Unit:** 90

Unit Summary:
A: General Drive Train Diagnosis
B: Clutch Diagnosis and Repair
C: Transmission/Transaxle Diagnose and Repair
D: Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joint Diagnosis and Repair
E: Drive Axle Diagnosis and Repair
  E.1: Ring and Pinion Gears an Differential Case Assembly
  E.2: Limited Slip Differential
  E.3: Drive Axles
F: Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair

Performance Assessments:

- Students will have the ability to plan and conduct an investigation using quantitative methods to model, design, evaluate and refine a solution to complex problems using the following vehicle diagnostic and repair process for manual drive train and axles.

Vehicle Repair Procedures	**21st Century / Leadership correlations**	**NGSS Science Correlations**
● Concern – Cause – Correction		

Verify / Confirm - Condition / Problem	Reason Effectively, Think Creatively,	Plan and conduct an investigation to gather evidence to compare the structure... Evaluate the validity and reliability of multiple claims... verifying the data when possible. Scientific inquiry... include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Research Information: How does system work? Technical Service Bulletins Flow Charts / Diagnostic procedures Wiring Diagram's Discuss in Group Use of multiple "sites" for common diagnostic procedures.	Use systems thinking, Analyze media, Apply technology effectively, Be responsible to others, Work effectively in diverse teams, Adapt to change,	Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources. Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
Student Service Manager or Asst. discussion.	Collaborate with others, Guide and lead others, Manage projects (and groups)	Design, evaluate, and/or Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Ask questions that arise from examining models or a theory to clarify relationships. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors
P&A Parts / look up Labor/ Print Estimate	Create media products, Communicate with adults...	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Call Customer / sell job / Estimate Time	Use and manage information, Communicate with adults...	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
Fix: Follow Technical Instructions / Perform Service	Solve Problems, Implement innovations, Apply technology effectively, Produce results,	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. Use a model to provide mechanistic accounts of phenomena.

Leadership Alignment:

- In small group's, students discuss strategies to make an effective transition from school to career and identify industry certification opportunities and create a presentation for class.

21st Century Skills:

- o Implement Innovations
- o Solve Problems
- **o** Communicate Clearly.

Industry Standards and/or Competencies:
The following technical competencies are produced and endorsed by the **National Automobile Technical Education Foundation (NATEF) for manual drive train and axles. Automotive Service Excellence (ASE) area A3.**

A. General: Drive Train Diagnosis

1. Identify and interpret drive train concerns; determine necessary action.
2. Research applicable vehicle and service information, fluid type, vehicle service history, service precautions, and technical service bulletins.
3. Check fluid condition; check for leaks; determine necessary action.
4. Drain and refill manual transmission/transaxle and final drive unit.

B. Clutch Diagnosis and Repair

1. Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action.
2. Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action.
3. Inspect and replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing and linkage, and pilot bearing/bushing (as applicable).
4. Bleed clutch hydraulic system.
5. Check and adjust clutch master cylinder fluid level; check for leaks.
6. Inspect flywheel and ring gear for wear and cracks; determine necessary action.
7. Measure flywheel runout and crankshaft end play; determine necessary action.

C. Transmission/Transaxle Diagnosis and Repair

1. Inspect, adjust, and reinstall shift linkages, brackets, bushings, cables, pivots, and levers.
2. Describe the operational characteristics of an electronically-controlled manual transmission/transaxle.
3. Diagnose noise concerns through the application of transmission/transaxle power flow principles.
4. Diagnose hard shifting and jumping out of gear concerns; determine necessary action.
5. Diagnose transaxle final drive assembly noise and vibration concerns; determine necessary action.
6. Disassemble, inspect clean, and reassemble internal transmission/transaxle components.

D. Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joint Diagnosis and Repair

1. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action.
2. Diagnose universal joint noise and vibration concerns; perform necessary action.
3. Inspect, remove, and replace front wheel drive (FWD) bearings, hubs, and seals.
4. Inspect, service, and replace shafts, yokes, boots, and universal/CV joints.
5. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles.

E. Drive Axle Diagnosis and Repair

E.1 Ring and Pinion Gears and Differential Case Assembly

1. Clean and inspect differential housing; check for leaks; inspect housing vent.
2. Check and adjust differential housing fluid level.
3. Drain and refill differential housing
4. Diagnose noise and vibration concerns; determine necessary action.
5. Inspect and replace companion flange and pinion seal; measure companion flange runout.

6. Inspect ring gear and measure runout; determine necessary action.
7. Remove, inspect, and reinstall drive pinion and ring gear, spacers, sleeves, and bearings.
8. Measure and adjust drive pinion depth.
9. Measure and adjust drive pinion bearing preload.
10. Measure and adjust side bearing preload and ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup or shim types).
11. Check ring and pinion tooth contact patterns; perform necessary action.
12. Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
13. Reassemble and reinstall differential case assembly; measure runout; determine necessary action.

E.2 Limited Slip Differential

1. Diagnose noise, slippage, and chatter concerns; determine necessary action.
2. Measure rotating torque; determine necessary action.

E.3 Drive Axles

1. Inspect and replace drive axle wheel studs.
2. Remove and replace drive axle shafts.
3. Inspect and replace drive axle shaft seals, bearings, and retainers.
4. Measure drive axle flange run out and shaft end play; determine necessary action.
5. Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine necessary action.

1. F. Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair

1. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets.
2. Inspect front-wheel bearings and locking hubs; perform necessary action(s).
3. Check for leaks at drive assembly seals; check vents; check lube level.
4. Identify concerns related to variations in tire circumference and/or final drive ratios.
5. Diagnose noise, vibration, and unusual steering concerns; determine necessary action.
6. Diagnose, test, adjust, and replace electrical/electronic components of four-wheel drive systems.
7. 7. Disassemble, service, and reassemble transfer case and components.

Aligned Washington State Academic Standards

Science	Below are the aligned standards addressed in this section: Integrated Science Lesson Objectives are from the 2014 NATEF/ASE publication "Being Relevant Matters" https://www.asealliance.org/wp-content/uploads/2016/05/Being-Relevant-Matters.pdf . NGSS and ELA Standards are correlated from a collaboration of Automotive, Science, ELA, OSPI teachers, and advisory group representative members. ***Integrated Science Lesson Objectives*** **Manual Transmission:** Coefficient of friction, Clutch materials, Disposal of fluids, Balance, Center of gravity, Harmonic effects, Simple machines, Gears & levers, Fluid types, Thermal metal fatigue, Definition of torque, States of a fastener, Chemistry of seals & sealants, Review of fundamentals of kinetic motion, Electrical fundamentals, Principles of vacuum **Washington Science Standards (Next Generation Science Standards):** HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

	HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS2-1 Motion and Stability: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Motion and Stability: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* HS-PS2-5 Motion and Stability: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS2-6 Motion and Stability: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* HS-PS3-1 Energy: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects) HS-PS3-3 Energy: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-PS4-2 Waves and their Applications in Technologies: Evaluate questions about the advantages of using digital transmission and storage of information HS-PS4-5 Waves and their Applications in Technologies: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* HS-LS2-7 Ecosystems; Interactions, Energy, and Dynamics: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* HS-ESS3-1 Earth and Human Activity: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2 Earth and Human Activity: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*

	HS-ESS3-4 Earth and Human Activity: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* HS-ETS1-3 Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 Engineering Design: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Unit 3: Brakes (ASE/NATEF: A-5)	**Total Learning Hours for Unit:** 180

Unit Summary:
A: General Brake System Diagnosis
B: Hydraulic System Diagnosis and Repair
C: Drum Brake Diagnosis and Repair
D: Disc Brake Diagnosis and Repair
E: Power-Assist Units Diagnosis and Repair
F: Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair
G: Electronic Brake, Traction and Stability Control Systems Diagnose and Repair

Performance Assessments:

- Students will have the ability to plan and conduct an investigation using quantitative methods to model, design, evaluate and refine a solution to complex problems using the following vehicle diagnostic and repair process for brake systems.

Vehicle Repair Procedures ● Concern – Cause – Correction	**21st Century / Leadership correlations**	**NGSS Science Correlations**
Verify / Confirm - Condition / Problem	Reason Effectively, Think Creatively,	Plan and conduct an investigation to gather evidence to compare the structure... Evaluate the validity and reliability of multiple claims... verifying the data when possible. Scientific inquiry... include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Analyze Data: Diagnose problem Data Notation: DTC's, Freeze Frame, Fuel Trim's, MAf's, measurements, mechanical and electronic testing.	Make Judgments and Decisions, Access and evaluate information, Apply technology effectively, Be self-directed learners, Be flexible,	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence... Use quantitative methods to compare the potential of different solutions. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

		Apply concepts of statistics and probability… to scientific and engineering questions and problems, using digital tools when feasible. Analyze data using computational models in order to make valid and reliable scientific claims.
Student Service Manager or Asst. discussion.	Collaborate with others, Guide and lead others, Manage projects (and groups)	Design, evaluate, and/or Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Ask questions that arise from examining models or a theory to clarify relationships. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors
P&A Parts / look up Labor/ Print Estimate	Create media products, Communicate with adults…	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Notation of performed / Estimate work order	Interact effectively with others,	Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Construct an oral and written argument or counter-arguments based on data and evidence.
Call Customer / sell job / Estimate Time	Use and manage information, Communicate with adults…	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
Fix: Follow Technical Instructions / Perform Service	Solve Problems, Implement innovations, Apply technology effectively, Produce results,	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. Use a model to provide mechanistic accounts of phenomena.

Leadership Alignment:

- Students create and complete appropriate documents such as electronic portfolio, personal resumé, employment application, letter of intent, letters of recommendation and thank you letters.
- Students complete job search documents, including job applications and W-4 forms.

21st Century Skills:

- Use Systems Thinking
- Use and Manage Information
- Manage Projects

Industry Standards and/or Competencies:

The following technical competencies are produced and endorsed by the **National Automobile Technical Education Foundation (NATEF) for brakes. Automotive Service Excellence (ASE) area A5.**

A. General: Brake Systems Diagnosis

1. Identify and interpret brake system concerns; determine necessary action.
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.
3. Describe procedure for performing a road test to check brake system operation; including an anti-lock brake system (ABS).
4. Install wheel and torque lug nuts.

B. Hydraulic System Diagnosis and Repair

1. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal's Law).
2. Measure brake pedal height, travel, and free play (as applicable); determine necessary action.
3. Check master cylinder for internal/external leaks and proper operation; determine necessary action.
4. Remove, bench bleed, and reinstall master cylinder.
5. Diagnose poor stopping, pulling or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action.
6. Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, and wear; check for loose fittings and supports; determine necessary action.
7. Replace brake lines, hoses, fittings, and supports.
8. Fabricate brake lines using proper material and flaring procedures (double flare and ISO types).
9. Select, handle, store, and fill brake fluids to proper level.
10. Inspect, test, and/or replace components of brake warning light system.
11. Identify components of brake warning light system.
12. Bleed and/or flush brake system.
13. Test brake fluid for contamination.

C. Drum Brake Diagnosis and Repair

1. Diagnose poor stopping noise, vibration, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action.
2. Remove, clean, inspect and measure break drum diameter; determine necessary action.
3. Refinish brake drum and measure final drum diameter; compare with specifications.
4. Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble.
5. Inspect wheel cylinders for leaks and proper operation; remove and replace as needed.
6. Pre-adjust brake shoes and parking brake; install brake drums or drum/hub assemblies and wheel bearings; perform final checks and adjustments.

D. Disc Brake Diagnosis and Repair

1. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pulsation concerns; determine necessary action.
2. Remove and clean caliper assembly; inspect for leaks and damage/wear to caliper housing; determine necessary action.
3. Clean and inspect caliper mounting and slides/pins for proper operation, wear, and damage; determine necessary action.
4. Remove, inspect, and replace pads and retaining hardware; determine necessary action.
5. Lubricate and reinstall caliper, pads, and related hardware; seat pads and inspect for leaks.
6. Clean and inspect rotor; measure rotor thickness, thickness variation, and lateral runout; determine necessary action.
7. Remove and reinstall rotor.
8. Refinish rotor on vehicle; measure final rotor thickness and compare with specifications.
9. Refinish rotor off vehicle; measure final rotor thickness and compare with specifications.
10. Retract and re-adjust caliper piston on an integrated parking brake system.
11. Check brake pad wear indicator; determine necessary action.
12. Describe importance of operating vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendations.

E. Power-Assist Units Diagnosis and Repair

1. Check brake pedal travel with, and without, engine running to verify proper power booster operation.
2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster.
3. Inspect vacuum-type power booster unit for leaks; inspect the check-valve for proper operation; determine necessary action.
4. Inspect and test hydraulically-assisted power brake system for leaks and proper operation; determine necessary action.
5. Measure and adjust master cylinder pushrod length.

1. F. Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair

1. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine necessary action.
2. Remove, clean, inspect, repack, and install wheel bearings; replace seals; install hub and adjust bearings.
3. Check parking brake cables and components for wear, binding, and corrosion; clean, lubricate, adjust or replace as needed.
4. Check parking brake operation and parking brake indicator light system operation; determine necessary action.
5. Check operation of brake stop light system.
6. Replace wheel bearing and race.
7. Remove and reinstall sealed wheel bearing assembly.
8. Inspect and replace wheel studs.

G. Electronic Brake, Traction and Stability Control Systems Diagnosis and Repair

1. Identify and inspect electronic brake control system components; determine necessary action.
2. Identify traction control/vehicle stability control system components.
3. Describe the operation of a regenerative braking system.
4. Diagnose poor stopping, wheel lock-up, abnormal pedal feel, unwanted application, and noise concerns associated with the electronic brake control system; determine necessary action.
5. Diagnose electronic brake control system electronic control(s) and components by retrieving diagnostic trouble codes, and/or using recommended test equipment; determine necessary action.
6. Depressurize high-pressure components of an electronic brake control system.
7. Bleed the electronic brake control system hydraulic circuits.
8. Test, diagnose, and service electronic brake control system speed sensors (digital and analog), toothed ring (tone wheel), and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO) (includes output signal, resistance, shorts to voltage/ground, and frequency data).
9. 9. Diagnose electronic brake control system braking concerns caused by vehicle modifications (tire size, curb height, final drive ratio, etc.).

Aligned Washington State Academic Standards to be addressed in this 180 hour sequence of instruction

	Below are the aligned standards addressed in this section: Integrated Science Lesson Objectives are from the 2014 NATEF/ASE publication "Being Relevant Matters" https://www.asealliance.org/wp-content/uploads/2016/05/Being-Relevant-Matters.pdf . NGSS and ELA Standards are correlated from a collaboration of Automotive, Science, ELA, OSPI teachers, and advisory group representative members.
Science	***Integrated Science Lesson Objectives*** **Brakes:** Torque & clamping force, Corrosion of materials, Deformation of metal, Chemistry of bonding agents, Chemistry of lubricants, Thermal effects on metals, Leverage, Vacuum principles, Review 4 stroke engine theory (intake), Chemistry of materials (seals), Principles of corrosion, Torque, States of fasteners, Electronic diagnostics, Energy transfer **Washington Science Standards (Next Generation Science Standards):**

	HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS2-1 Motion and Stability: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Motion and Stability: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* HS-PS2-5 Motion and Stability: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS2-6 Motion and Stability: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* HS-PS3-1 Energy: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects) HS-PS3-3 Energy: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS-PS4-2 Waves and their Applications in Technologies: Evaluate questions about the advantages of using digital transmission and storage of information HS-PS4-5 Waves and their Applications in Technologies: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* HS-LS2-7 Ecosystems; Interactions, Energy, and Dynamics: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* HS-ESS3-1 Earth and Human Activity: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

	HS-ESS3-2 Earth and Human Activity: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* HS-ESS3-4 Earth and Human Activity: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* HS-ETS1-3 Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 Engineering Design: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Unit 4: Electrical/Electronics (ASE/NATEF: A-6)	**Total Learning Hours for Unit:** 180

Unit Summary:

A. General Electrical System Diagnose
B. Battery Diagnose and Service
C. Starting System Diagnose and Repair
D. Charging System Diagnostic and Repair
E. Lighting System Diagnosis and Repair
F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair
G. Horn, Wiper/Washer Diagnosis and Repair
H. Accessories Diagnosis and Repair

Performance Assessments:

- Students will have the ability to plan and conduct an investigation using quantitative methods to model, design, evaluate and refine a solution to complex problems using the following vehicle diagnostic and repair process for electrical/electronics.

Vehicle Repair Procedures ● Concern – Cause – Correction	**21st Century / Leadership correlations**	**NGSS Science Correlations**
Verify / Confirm - Condition / Problem	Reason Effectively, Think Creatively,	Plan and conduct an investigation to gather evidence to compare the structure... Evaluate the validity and reliability of multiple claims... verifying the data when possible. Scientific inquiry... include logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.
Analyze Data: Diagnose problem Data Notation: DTC's, Freeze Frame, Fuel Trim's, MAf's, measurements, mechanical and electronic testing.	Make Judgments and Decisions, Access and evaluate information,	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence... Use quantitative methods to compare the potential of different solutions.

	Apply technology effectively, Be self-directed learners, Be flexible,	Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Apply concepts of statistics and probability... to scientific and engineering questions and problems, using digital tools when feasible. Analyze data using computational models in order to make valid and reliable scientific claims.
Research Information: How does system work? Technical Service Bulletins Flow Charts / Diagnostic procedures Wiring Diagram's Discuss in Group Use of multiple "sites" for common diagnostic procedures.	Use systems thinking, Analyze media, Apply technology effectively, Be responsible to others, Work effectively in diverse teams, Adapt to change,	Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources. Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
Student Service Manager or Asst. discussion.	Collaborate with others, Guide and lead others, Manage projects (and groups)	Design, evaluate, and/or Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Ask questions that arise from examining models or a theory to clarify relationships. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors
P&A Parts / look up Labor/ Print Estimate	Create media products, Communicate with adults...	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Notation of performed / Estimate work order	Interact effectively with others,	Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. Construct an oral and written argument or counter-arguments based on data and evidence.
Instructor Approval (Discuss in Group)	Communicate clearly,	Constructing explanations, arguments from evidence Create a computational model or simulation of a phenomenon, designed device, process, or system. Make and defend a claim based on evidence... Communicate technical information or ideas

Call Customer / sell job / Estimate Time	Use and manage information, Communicate with adults…	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
Fix: Follow Technical Instructions / Perform Service	Solve Problems, Implement innovations, Apply technology effectively, Produce results,	Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. Use a model to provide mechanistic accounts of phenomena.

Leadership Alignment:

- Students participate in mock interviews demonstrating proper interview techniques in various situations. (Small groups, class, industry partners, etc.).

21st Century Skills:

- Adapt to Change
- Be Flexible
- Interact Effectively with Others

Industry Standards and/or Competencies:

The following technical competencies are produced and endorsed by the **National Automobile Technical Education Foundation (NATEF) for electrical/electronics. Automotive Service Excellence (ASE) area A6.**

A. General: Electrical System Diagnosis

1. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.
2. Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law).
3. Demonstrate proper use of a digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow and resistance.
4. Demonstrate knowledge of the causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits.
5. Check operation of electrical circuits with a test light.
6. Check operation of electrical circuits with fused jumper wires.
7. Use wiring diagrams during the diagnosis (troubleshooting) of electrical/electronic circuit problems.
8. Diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action.
9. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action.
10. Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; determine necessary action.
11. Replace electrical connectors and terminal ends.
12. Repair wiring harness.
13. Perform solder repair of electrical wiring.
14. Check electrical/electronic circuit waveforms; interpret readings and determine needed repairs.
15. Repair CAN/BUS wiring harness.

B. Battery Diagnosis and Service

1. Perform battery state-of-charge test; determine necessary action.
2. Confirm proper battery capacity for vehicle application; perform battery capacity test; determine necessary action.
3. Maintain or restore electronic memory functions.
4. Inspect and clean battery; fill battery cells; check battery cables, connectors, clamps, and hold-downs.
5. Perform slow/fast battery charge according to manufacturer's recommendations.
6. Jump-start vehicle using jumper cables and a booster battery or an auxiliary power supply.
7. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions.

8. Identify electronic modules, security systems, radios, and other accessories that require re-initialization or code entry after reconnecting vehicle battery.
9. Identify hybrid vehicle auxiliary (12v) battery service, repair, and test procedures.

C. Starting System Diagnosis and Repair
1. Perform starter current draw tests; determine necessary action.
2. Perform starter circuit voltage drop tests; determine necessary action.
3. Inspect and test starter relays and solenoids; determine necessary action.
4. Remove and install starter in a vehicle.
5. Inspect and test switches, connectors, and wires of starter control circuits; determine necessary action.
6. Differentiate between electrical and engine mechanical problems that cause a slow-crank or a no-crank condition.

D. Charging System Diagnosis and Repair
1. Perform charging system output test; determine necessary action.
2. Diagnose (troubleshoot) charging system for causes of undercharge, no-charge, or overcharge conditions.
3. Inspect, adjust, or replace generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment.
4. Remove, inspect, and re-install generator (alternator).
5. Perform charging circuit voltage drop tests; determine necessary action.

E. Lighting Systems Diagnosis and Repair
1. Diagnose (troubleshoot) the causes of brighter-than-normal, intermittent, dim, or no light operation; determine necessary action.
2. Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed.
3. Aim headlights.
4. Identify system voltage and safety precautions associated with high-intensity discharge headlights.

F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair
1. Inspect and test gauges and gauge sending units for causes of abnormal gauge readings; determine necessary action.
2. Diagnose (troubleshoot) the causes of incorrect operation of warning devices and other driver information systems; determine necessary action.

G. Horn and Wiper/Washer Diagnosis and Repair
1. Diagnose (troubleshoot) causes of incorrect horn operation; perform necessary action.
2. Diagnose (troubleshoot) causes of incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action.
3. Diagnose (troubleshoot) windshield washer problems; perform necessary action.

H. Accessories Diagnosis and Repair
1. Diagnose (troubleshoot) incorrect operation of motor-driven accessory circuits; determine necessary action.
2. Diagnose (troubleshoot) incorrect electric lock operation (including remote keyless entry); determine necessary action.
3. Diagnose (troubleshoot) incorrect operation of cruise control systems; determine necessary action.
4. Diagnose (troubleshoot) supplemental restraint system (SRS) problems; determine necessary action.
5. Disable and enable an airbag system for vehicle service; verify indicator lamp operation.
6. Remove and reinstall door panel.
7. Check for module communication errors (including CAN/BUS systems) using a scan tool.
8. 8. Describe the operation of keyless entry/remote-start systems.

Aligned Washington State Academic Standards to be addressed in this 180 hour sequence of instruction

Science	Below are the aligned standards addressed in this section: Integrated Science Lesson Objectives are from the 2014 NATEF/ASE publication "Being Relevant Matters" https://www.asealliance.org/wp-content/uploads/2016/05/Being-Relevant-Matters.pdf . NGSS and ELA Standards are correlated from a collaboration of Automotive, Science, ELA, OSPI teachers, and advisory group representative members.

	Integrated Science Lesson Objectives **Electrical/Electronic Systems:** Electrical Fundamentals (Ohm's Law), Environmental Science, Electronics Diagnostics, Chemistry of Batteries (Electrolysis), Physical Science, Personal Protection, Computer Science, Electromagnetic induction (Faraday's Law), Basic Engine Theory, Principals of Corrosion, Electrical Safety, Piezoelectric effect, Chemical reactions & accelerants, Electromechanical Theory, Electro Mechanic Wave Theory **Washington Science Standards (Next Generation Science Standards):** HS-PS1-2 Matter and its Interactions: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-3 Matter and its Interactions: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles HS-PS1-4 Matter and its Interactions: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy HS-PS1-5 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6 Matter and its Interactions: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS2-1 Motion and Stability: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Motion and Stability: Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* HS-PS2-5 Motion and Stability: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. HS-PS2-6 Motion and Stability: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* HS-PS3-1 Energy: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Energy: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects) HS-PS3-3 Energy: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* HS-PS3-4 Energy: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS-PS3-5 Energy: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

	HS-PS4-2 Waves and their Applications in Technologies: Evaluate questions about the advantages of using digital transmission and storage of information HS-PS4-5 Waves and their Applications in Technologies: Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* HS-LS2-7 Ecosystems; Interactions, Energy, and Dynamics: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* HS-ESS3-1 Earth and Human Activity: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2 Earth and Human Activity: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* HS-ESS3-4 Earth and Human Activity: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* HS-ETS1-3 Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4 Engineering Design: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Appendix A	
Leadership Alignment	15 hours embedded into each section
Leadership activities include NATEF/ASE Supplemental tasks and 21st Century Skills. These Soft/Life skills, embedded into the curriculum and instruction for each unit of instruction and are being taught and assessed within the curriculum for all students.	
NATEF/ASE soft/life skills and 21st Century Skills are clearly articulated during every **Vehicle Repair Procedures,** Concern – Cause – Correction. Students will demonstrate the ability to communicate clearly through their group project presentations.	
Industry Standards and Competencies	
This section should include appropriate industry standards and competencies aligned to the course, as is a required section: **Shop and Personal Safety** 1. Identify general shop safety rules and procedures. 2. Utilize safe procedures for handling of tools and equipment. 3. Identify and use proper placement of floor jacks and jack stands. 4. Identify and use proper procedures for safe lift operation. 5. Utilize proper ventilation procedures for working within the lab/shop area. 6. Identify marked safety areas.	

7. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment.
8. Identify the location and use of eye wash stations.
9. Identify the location of the posted evacuation routes.
10. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities.
11. Identify and wear appropriate clothing for lab/shop activities.
12. Secure hair and jewelry for lab/shop activities.
13. Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high voltage circuits.
14. Demonstrate awareness of the safety aspects of high voltage circuits (such as high intensity discharge (HID) lamps, ignition systems, injection systems, etc).
15. Locate and demonstrate knowledge of material safety data sheets (MSDS).

Tools and Equipment

1. Identify tools and their usage in automotive applications.
2. Identify standard and metric designation.
3. Demonstrate safe handling and use of appropriate tools.
4. Demonstrate proper cleaning, storage, and maintenance of tools and equipment.
5. Demonstrate proper use of precision measuring tools (i.e. micrometer, dial-indicator, dial-caliper).

Preparing Vehicle for Service

1. Identify information needed and the service requested on a repair order.
2. Identify purpose and demonstrate proper use of fender covers, mats.
3. Demonstrate use of the three C's (concern, cause, and correction).
4. Review vehicle service history.
5. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

Preparing Vehicle for Customer

1. Ensure vehicle is prepared to return to customer per school/company policy (floor mats, steering wheel cover).

Career Planning

- Complete, discuss, and analyze the results of personality, career interest, and aptitude assessments;
- Explore the career clusters as defined by the U.S. Department of Education and summarize the career opportunities in a cluster of personal interest;
- Create a personal career portfolio including academic, certification and technical-skill requirement, career opportunities, expected wages, skills and aptitude necessary and the impact of technology on careers of personal interest.
- Determine academic/training or certification requirements for transition from one learning level to the next and explore opportunities for earning credit/certifications in high school such as advanced placement, tech prep, International Baccalaureate, college in the high school, military and apprenticeship opportunities.
- Develop and analyze tables, charts, and graphs related to career interests and make oral presentation regarding the career pathway of your choice.
- Develop an awareness of financial aid, scholarships, and other sources of income to support postsecondary education/training and discuss the impact of effective college and career planning.

- Identify how performance on assessments such as the SAT®, ACT®, ASVAB®, COMPASS® and ACCUPLACER® impact personal academic and career goals.
- Prepare a personal budget reflecting desired lifestyle and compare and contrast at least three careers of interest in regards to salary expectations and education/training costs.
- Prepare a program of study for at least one career of interest
- Apply knowledge gained from individual assessment to a set of goals and a career plan
- Develop strategies to make an effective transition from school to career
- Identify industry certification opportunities

Personal Success

- Reports to work daily on time; able to take directions and motivated to accomplish the task at hand.
- Dresses appropriately and uses language and manners suitable for the workplace.
- Maintains appropriate personal hygiene
- Meets and maintains employment eligibility criteria, such as drug/alcohol-free status, clean driving record, etc.
- Demonstrates honesty, integrity and reliability
- Implement effective study skills for academic success;
- Develop personal goals using SMART (Specific Measurable Attainable Realistic Timely), objectives and strategies.
- Use interpersonal skills to facilitate effective teamwork;
- Use a problem-solving model and critical-thinking skills to make informed decisions;
- Use effective time-management and goal-setting strategies;
- Effectively use information and communication technology tools; and
- Identify skills that can be transferable among a variety of careers.
- Create and complete appropriate documents such as electronic portfolio, personal resume, employment application, letter of intent, letters of recommendation and thank you letters.
- Complete job search documents, including job applications and W-4 forms;
- Demonstrate proper interview techniques in various situations.

Employability and Entrepreneurship

- Complies with workplace policies/laws
- Contributes to the success of the team, assists others and requests help when needed.
- Works well with all customers and coworkers.
- Negotiates solutions to interpersonal and workplace conflicts.
- Contributes ideas and initiative
- Follows directions
- Communicates (written and verbal) effectively with customers and coworkers.
- Reads and interprets workplace documents; writes clearly and concisely.
- Analyzes and resolves problems that arise in completing assigned tasks
- Organizes and implements a productive plan of work.
- Uses scientific, technical, engineering and mathematics principles and reasoning to accomplish assigned task
- Identifies and addresses the needs of all customers, providing helpful, courteous and knowledgeable service and advice as needed.

- Demonstrate effective verbal, nonverbal, written, and electronic communication skills;
- Evaluate the impact of positive and negative personal choices, including use of electronic communications such as social networking sites;
- Model characteristics of effective leadership, teamwork, and conflict management;
- Recognize the importance of a healthy lifestyle, including the ability to manage stress;
- Explore and model characteristics necessary for professional success such as work ethics, integrity, dedication, perseverance, and the ability to interact with a diverse population; and
- Complete activities using project- and time-management techniques.
- Identify and model appropriate grooming and appearance for the workplace;
- Demonstrate dependability, punctuality, and initiative;
- Research positive interpersonal skills, including respect for diversity;
- Model appropriate business and personal etiquette in the workplace;
- Exhibit productive work habits, ethical practices, and a positive attitude;
- Demonstrate the ability to work with the other employees to support the organization and complete assigned tasks;
- Demonstrate willingness to learn and further develop skills
- Describe the importance of having a positive attitude and techniques that boost morale
- Show initiative by coming up with unique solutions and taking on extra responsibilities
- Explain the importance of setting goals and demonstrate the ability to set, reach, and evaluate goals
- Explain the importance of taking pride in work accomplished and extrinsic and intrinsic motivators that can be used to increase pride
- Identify how to prioritize work to fulfill responsibilities and meet deadlines;
- Research and compare published workplace policies and procedures;
- Summarize provisions of the Fair Labor Standards Act;
- Describe the consequences of breach of confidentiality;

Standards and Competencies	
Standard/Unit: A-6 ELECTRICAL/ELECTRONIC SYSTEMS (major)	
Competencies 58 Total, 52 AST	**Unit Learning Hours:** 165 hours + 15 hrs. soft/life skills = 180

A. General: Electrical System Diagnosis	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.	P-1	X	Environmental Science Research multiple sources acquiring technical information Choosing solution criteria constraints	HS-ESS3-2 HS-ESS3-4 HS-ETS1-2 HS-ETS1-4

2. Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law).	P-1	X	electrical fundamentals wiring diagrams, computerized service information, DVOM usage, Electricity and magnetism electromagnetic force Energy; objects interacting through electric or magnetic field...	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
3. Demonstrate proper use of a digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow and resistance.	P-1	X	electrical fundamentals wiring diagrams, computerized service information, DVOM usage Electricity and magnetism, electromagnetic force	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
4. Demonstrate knowledge of the causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits.	P-1	X	electrical fundamentals wiring diagrams, computerized service information, DVOM usage, OHMS law, resistance/ current follow/heat, electromagnetic force, Atoms are composed of protons, neutrons, electron mass Forces and Interactions; - evidence that an electric current produce a magnetic field and that a changing magnetic field can produce an electric current...	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
5. Check operation of electrical circuits with a test light.	P-1	X	electrical fundamentals simple circuit test light, wiring diagram & component locator information	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
6. Check operation of electrical circuits with fused jumper wires.	P-1	X	electrical fundamentals Sacrificial anodes, DVOM usage, by-passing electrical devices, wiring diagram & component locator information	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
7. Use wiring diagrams during the diagnosis (troubleshooting) of electrical/electronic circuit problems.	P-1	X	electronic diagnosis wiring diagrams, computerized service information, DVOM usage	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4

8. Diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action.	P-1	X	battery chemistry, electronic diagnostics testing parasitic draw & voltage drop, Choosing solution, ability to solve, Question, Investigate, Electricity and magnetism, electromagnetic force	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
9. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action.	P-1	X	thermodynamics in electricity circuit protection, sacrificial anodes, wire size vs circuit load, OHMs Law	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
10. Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; determine necessary action.	P-1	X	Electromagnetism wiring diagrams, computerized service information, DVOM usage Matter and its Interactions; gather evidence	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
11. Replace electrical connectors and terminal ends.	P-1	X	science of soldering understanding melting points, heat transfer, flux types, movement of liquid metals to solids, corrosion & oxidation of dis-similar metals, sealing circuit or repair	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
12. Repair wiring harness.	P-1	X	science of soldering understanding melting points, heat transfer, flux types, movement of liquid metals to solids, corrosion & oxidation of dis-similar metals, sealing circuit or repair	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
13. Perform solder repair of electrical wiring.	P-1	X	science of soldering understanding melting points, heat transfer, flux types, movement of liquid metals to solids, corrosion & oxidation of dis-similar metals, sealing circuit or repair	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
14. Check electrical/electronic circuit waveforms; interpret readings and determine needed repairs.	P-2		electronic diagnosis PWM ,Waves and their Applications in Technologies for Information Transfer; - relationships among the frequency, wavelength, and speed	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4

15. Repair CAN/BUS wiring harness.	P-1		Interactions of Electronic module communication, wiring diagrams, computerized service information, DVOM usage, Scan tool data Engineering Design; - complex real-world problem	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4 ...

B. Battery Diagnosis and Service	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Perform battery state-of-charge test; determine nec action.	P-1	X	battery chemistry Hydrometer & DVOM usage, specific gravity of electrolyte vs. cell charge	HS-PS1-4 HS-PS3-1
2. Confirm proper battery capacity for vehicle application; perform battery capacity test; determine necessary action.	P-1	X	electronic diagnosis Load Test, Electron Flow, Electronic meter usage	HS-PS3-3 HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
3. Maintain or restore electronic memory functions.	P-1	X	electronic diagnosis Computerized service information, procedural steps,	HS-PS2-6 HS_PS3-1
4. Inspect and clean battery; fill battery cells; check battery cables, connectors, clamps, and hold-downs.	P-1	X	battery chemistry, electronic diagnosis Hydrometer & DVOM usage, specific gravity of electrolyte vs. cell charge given constraints to convert one form of energy into another form of energy...	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
5. Perform slow/fast battery charge according to manufacturer's recommendations.	P-1	X	charging principles Heat of Electron flow through cable size and Electromotive force, Principles of Gassing and venting of Sulfuric electrolyte (H2) and cell plate design	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
6. Jump-start vehicle using jumper cables and a booster battery or an auxiliary power supply.	P-1	X	Heat of Electron flow through cable size and Electromotive force, Principles of Gassing and venting of	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2

			Sulfuric electrolyte (H2) and cell plate design	HS-PS4-5 HS-ETS1-2 HS-ETS1-4
7. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions.	P-3	X	electronic diagnosis, personal protective equipment (PPE) High voltage, AC/DC motors, Orange cables, DEATH, OSHA safety precautions, Special tools, Lock-Out switch	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
8. Identify electronic modules, security systems, radios, and other accessories that require reinitialization or code entry after reconnecting vehicle battery.	P-1	X	computer science Computerized service information, procedural steps,	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
9. Identify hybrid vehicle auxiliary (12v) battery service, repair, and test procedures.	P-3	X	battery chemistry Hybrid cautions Hydrometer & DVOM usage, specific gravity of electrolyte vs. cell charge	HS-PS3-1

C. Starting System Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Perform starter current draw tests; determine necessary action.	P-1	X	electrical fundamentals Cranking Amp spec, Computerized service information, Electronic meter usage, Ohms Law, Electricity and magnetism electromagnetic force	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
2. Perform starter circuit voltage drop tests; determine necessary action.	P-1	X	electrical fundamentals DVOM usage	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4

3. Inspect and test starter relays and solenoids; determine necessary action.	P-2	X	Electromagnetism Electronic Testing using wiring diagrams & DVOM	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
4. Remove and install starter in a vehicle.	P-1	X	Disassembly, Cleaning, Sealing, Assembling using procedural steps from electronic media	HS-PS2-6
5. Inspect and test switches, connectors, and wires of starter control circuits; determine necessary action.	P-2	X	electrical fundamentals Electronic Testing using wiring diagrams and flow chart/trees, DVOM	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4
6. Differentiate between electrical and engine mechanical problems that cause a slow-crank or a no-crank condition.	P-2	X	electrical fundamentals, basic engine theory Ignition "kick-backs", coefficient of friction of internal parts, Torque vs. power of chemical – electrical - kinetic	HS-PS1-3 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-4 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4

D. Charging System Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Perform charging system output test; determine necessary action.	P-1	X	electromagnetic induction Interpret computerized service information, Electronic meter usage, Ohms Law, computer Scan data, understand Diode theory & voltage regulation	HS-PS2-5

2. Diagnose (troubleshoot) charging system for causes of undercharge, no-charge, or overcharge conditions.	P-1	X	principles of corrosion Electro-Magnetic induction principles, Electronic Testing using wiring diagrams & DVOM, DSO voltage waveforms,	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
3. Inspect, adjust, or replace generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment.	P-1	X	Disassembly, Cleaning, Sealing, Assembling using procedural steps from electronic media	HS-PS2-5 HS-PS2-6
4. Remove, inspect, and re-install generator (alternator).	P-1	X	Disassembly, Cleaning, Sealing, Assembling using procedural steps from electronic media	HS-PS2-6
5. Perform charging circuit voltage drop tests; determine necessary action.	P-1	X	electrical fundamentals Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5

E. Lighting Systems Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Diagnose (troubleshoot) the causes of brighter-than-normal, intermittent, dim, or no light operation; determine necessary action.	P-1	X	electrical fundamentals Voltage drop principles, Electronic Testing using wiring diagrams, ground distribution location & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
2. Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed.	P-1	X	electrical fundamentals Voltage drop principles, Electronic Testing using wiring diagrams, ground distribution location & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
3. Aim headlights.	P-2	X	Computerized service information, procedural steps	
4. Identify system voltage and safety precautions associated with high-intensity discharge headlights.	P-2	X	electrical fundamentals, electrical safety Transformers and voltage stepping	HS-PS3-1

F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**

1. Inspect and test gauges and gauge sending units for causes of abnormal gauge readings; determine necessary action.	P-2	X	electronic diagnosis Ohms law, elect meter usage, positive and negative coefficient sensors and thermistors	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
2. Diagnose (troubleshoot) the causes of incorrect operation of warning devices and other driver information systems; determine necessary action.	P-2	X	electronic diagnosis Ohms law, elect meter usage, positive and negative coefficient sensors and thermistors, complex systems, Question, Investigate, Explain, Communicate Clearly, Choosing solution, ability to solve	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5

G. Horn and Wiper/Washer Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Diagnose (troubleshoot) causes of incorrect horn operation; perform necessary action.	P-1	X	electronic diagnosis wiring diagrams, computerized service information, DVOM usage, Scan tool data	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
2. Diagnose (troubleshoot) causes of incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action.	P-2	X	electronic diagnosis wiring diagrams, computerized service information, DVOM usage, Scan tool data	HS-PS2-5
3. Diagnose (troubleshoot) windshield washer problems; perform necessary action.	P-2	X	electronic diagnosis wiring diagrams, computerized service information, DVOM usage, Scan tool data	HS-PS1-3 HS-PS1-5 HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-1 HS-PS4-2 HS-PS4-5 HS-ETS1-2 HS-ETS1-4

H. Accessories Diagnosis and Repair	**Priority**	**AST TASK**	**Science Principle/Concept Being Relevant Matters Scientific Application**	**NGSS Aligned Standards**
1. Diagnose (troubleshoot) incorrect operation of motor-driven accessory circuits; determine necessary action.	P-2	X	electronic diagnosis Electronic Testing using wiring diagrams & DVOM In complex systems, Question, Investigate, Explain, Communicate Clearly, Choosing solution, ability to solve	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5

2. Diagnose (troubleshoot) incorrect electric lock operation (including remote keyless entry); determine necessary action.	P-2	X	electronic diagnosis Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
3. Diagnose (troubleshoot) incorrect operation of cruise control systems; determine necessary action.	P-3	X	electronic diagnosis Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
4. Diagnose (troubleshoot) supplemental restraint system (SRS) problems; determine necessary action.	P-2	X	chemical reactions Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
5. Disable and enable an airbag system for vehicle service; verify indicator lamp operation.	P-1	X	Scan tool actuation test/steps, Computerized service information, procedural steps	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
6. Remove and reinstall door panel.	P-1	X	Computerized service information, procedural steps	
7. Check for module communication errors (including CAN/BUS systems) using a scan tool.	P-2	X	computer science Electronic Testing using wiring diagrams & DVOM, scan tool data	HS-ETS1-2
8. Describe the operation of keyless entry/remote-start systems.	P-3	X	electromagnetics, computer science Electronic Testing using wiring diagrams & DVOM, re-flash procedures	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
9. Verify operation of instrument panel gauges and warning/indicator lights; reset maintenance indicators.	P-1	X	electrical fundamentals Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
10. Verify windshield wiper and washer operation, replace wiper blades.	P-1	X	electro-mechanical Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
11. Diagnose (troubleshoot) radio static and weak, intermittent, or no radio reception; determine necessary action.	P-3		electromagnetic wave theory Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5

12. Diagnose (troubleshoot) body electronic system circuits using a scan tool; determine necessary action.	P-3		electronic diagnosis Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
13. Diagnose the cause(s) of false, intermittent, or no operation of anti-theft systems.	P-3		electronic diagnosis, computer science Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5
14. Describe the process for software transfers, software updates, or flash reprogramming on electronic modules.	P-3		computer science Electronic Testing using wiring diagrams & DVOM	HS-PS2-3 HS-PS2-5 HS-PS2-6 HS-PS3-1 HS-PS3-5 HS-PS4-5

The 21st Century Skills should be taught and assessed throughout the course. This table should be included at the end of this document.

21st Century Skills		
Check those that students will demonstrate in this course:		
LEARNING & INNOVATION **Creativity and Innovation** ☒Think Creatively ☒Work Creatively with Others ☒Implement Innovations **Critical Thinking and Problem Solving** ☒Reason Effectively ☒**U**se Systems Thinking ☒Make Judgments and Decisions ☒Solve Problems **Communication and Collaboration** ☒Communicate Clearly ☒Collaborate with Others	**INFORMATION, MEDIA & TECHNOLOGY SKILLS** **Information Literacy** ☒Access and /evaluate Information ☒Use and Manage Information **Media Literacy** ☒Analyze Media ☒Create Media Products **Information, Communications and Technology (ICT Literacy)** ☒Apply Technology Effectively	**LIFE & CAREER SKILLS** **Flexibility and Adaptability** ☒Adapt to Change ☒Be Flexible **Initiative and Self-Direction** ☒Manage Goals and Time ☒Work Independently ☒Be Self-Directed Learners **Social and Cross-Cultural** ☒Interact Effectively with Others ☒Work Effectively in Diverse Teams **Productivity and Accountability** ☒Manage Projects ☒Produce Results **Leadership and Responsibility** ☒Guide and Lead Others ☒Be Responsible to Others